3M™ Cold Shrink Silicone Rubber Termination Kit QT-III,
7620-S, 7680-S and 7690-S Series 5 - 34.5 kV

Data Sheet **August 2008**

Product Description

3M™ Cold Shrink Silicone Rubber Termination Kit QT-III, 7620-S, 7680-S and 7690-S Series contain one-piece, skirted, silicone rubber terminations, qualified as IEEE Standard 48-1996 Class 1 for outdoor weather-exposed applications. The termination assemblies consist of a skirted insulator, high-dielectric constant (Hi-K) stress control tube*, conformable Hi-K stress controlling compound and built-in silicone top seal. The insulator is made of a dark gray silicone rubber with excellent tracking resistance and hydrophobic properties.

***7620-S and 7621-S designed and assembled with stress controlling compound only.**

The complete assembly is pre-stretched and loaded onto a removable core. The disposable core can be recycled. The kits are designed for terminating solid dielectric shielded power cables rated 5 through 34.5 kV, with tape shield, wire shield and UniShield® constructions.

Kit Contents

- 3 Hi-K, tracking resistant, silicone rubber terminations
- 3 Pre-formed ground braids
- 3 Constant force springs
- 6 strips sealing mastic
- 1 Cable preparation kit
- 1 Instruction sheet

Features

- Conforms to the IEEE Standard 48-1990 Class 1 requirements for 5, 8.7, 15 25/28 and 34.5 kV terminations
- One-piece versatile design, allowing quick installation and accommodating a wide range of cable sizes
- Cold Shrink delivery system for easy installation: simply place termination over prepared cable and unwind core to shrink into place (no force fit required)
- Hi-K stress control: specially formulated high dielectric constant material minimizes surfaces stress by more uniformly distributing the electrical field over the entire surface of the insulator
- Compact design provides for easier installation in restricted spaces
- Silicone rubber insulators, EPDM stress control tubes, stress controlling compound and silicone sealing compound are compatible with all common solid dielectric insulations, such as polyethylene (PE), cross-linked polyethylene (XLPE) and ethylene propylene rubber (EPR)

Stress Control

The QT-III termination controls the electric field stress distribution with special Hi-K materials, which are an integral part of the termination. The Hi-K materials, with a dielectric constant (K) of greater than 15, capacitively distributes the field that surrounds the termination.

The stress concentrations in a continuous length of shielded cable are typically 50 V/mil adjacent to the shield to about 70 V/mil at the conductor. The QT-III reduces the cable stresses at the termination to less that those in the continuous shielded portion of the cable.

Electrical flux is refracted to distribute the voltage stress in a controlled manner along the entire termination length extending beyond the cable shield cutoff. By controlling the electric field, the stress concentrations on the termination insulator surface are kept below 15 V/mil at rated voltage. This stress distribution permits high power frequency performance and impulse performance with a compact termination design.

Figure 1 below illustrates an actual computerized stress plot of the QT-III termination.

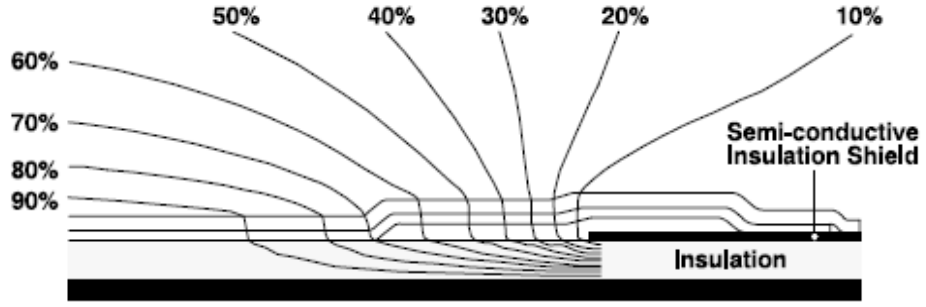


Figure 1

Applications

3M™ Cold Shrink Silicone Rubber Termination Kit QT-III, 7620-S, 7680-S and 7690-S Series are used to terminate tape shield, wire shield and UniShield® power cable rated 5 – 34.5 kV, having extruded solid dielectric insulation as follows:

- Polyethylene (high and low density), cross-linked polyethylene (XLP) and ethylene propylene rubber 9EPR)
- The terminations are light weight for either free-hanging or bracket-mounting arrangements.
- They can be used in both protected and weather-exposed contaminated areas

The amount of airborne contamination determines the operating environment. Operating environments are described as areas having varying degrees of airborne contaminant or pollution severity that may, or may not affect the long-term performance of terminations. These operating environments are defined as light, medium, heavy and extremely heavy variations of pollution severity. The appropriate termination selection depends on the system voltage and operating environment *(see tables below)*.

Recommended Application Guide

Termination Kit	System Voltage	Operating Environment			
		Light	Medium	Heavy	Extremely Heavy
(2 skirt) 7620-S-2 – 76-21-S-2	5 & 8 kV	✓	✓	✓	
(2 Skirt) 7622-S-2	15 kV	✓	✓	✓	
(4 Skirt) 7692-S-4 – 7696-S-4	15 kV	✓	✓	✓	✓
(8 Skirt) 7683-S-8 – 7686-S-8	15 kV	✓	✓	✓	✓
(4 Skirt) 7692-S-4 – 7696-S-4	25/28 kV	✓	✓	✓	
(8 Skirt) 7683-S-8 – 7686-S-8	25/28 kV	✓	✓	✓	✓
(8 Skirt) 7683-S-8 – 7686-S-8	34.5 kV	✓	✓	✓	*

Recommended operation environments are marked with a check (✓).

*Consult 3M sales representative.

Pollution Severity Level Guide

Light	Heavy
• Areas without industry and with low-density housing • Areas subjected to frequent winds and/or rainfall with low-density industry and housing • Agricultural areas ⋆ • Mountainous areas All of these regions should be situated at least 7 miles from the coast and should not be exposed to coastal winds.*	• High-density industrial areas and some urban areas with high-density housing, especially those with infrequent rainfall • Areas subjected to a moderate concentration of conductive dust, particularly industrial smoke-producing deposits • Areas generally close to the coast and exposed to coastal spray or to strong winds carrying sand and salt, and subjected to regular condensation
Medium	**Extremely Heavy**
• Non-polluting industrial areas subject to infrequent rainfall and with average-density housing • Areas subject to frequent winds and/or rainfall with high-density industry and housing • Areas exposed to wind from the coast, but generally over two miles from the coast	• Usually very limited areas having extremely heavy pollutants from industrial sites, especially those located near oceans and subjected to prevailing winds from the sea • Very small isolated areas where terminations are located immediately adjacent to a pollutant source, especially downwind (cement plants, paper mills, etc.)

⋆Use of fertilizers by spraying or the burning of crop residues, can lead to a higher pollution level due to dispersal by wind.

* Distances from coast depend on the topography of the coastal area and on the extreme wind conditions.

Environmental Classification

When airborne contaminants are deposited on a termination surface, destructive leakage currents can be initiated when the surface becomes wet. Fog and drizzle are worse than rain. Rain tends to wash the pollutants off the termination while fog will wet the pollutants, making the surface conductive to varying degrees, promoting leakage current formation. This is most typical of hydrophilic surfaces typified by porcelain *(Figure2)*.

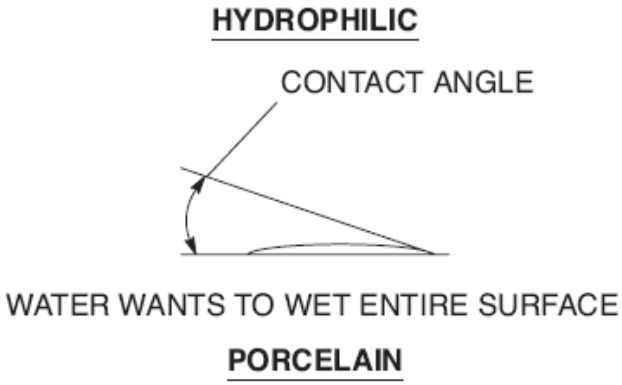


Figure 2

The surface of the QT-III silicone insulator is hydrophobic, which makes it less likely to erode or track because the surface does not wet readily *(Figure 3)*. This either prevents or minimizes leakage current formation. On occasion severe environmental conditions can be sustained for long time periods and cause any polymeric surface to lose its hydrophobicity. However, the silicone insulator surface will re-establish its hydrophobic surface within 24 hours. This prevents the surface from becoming increasingly hydrophilic with time, which would result in premature failure of the flashover. This unique ability of the QT-III silicone is a major factor to insure long service life.

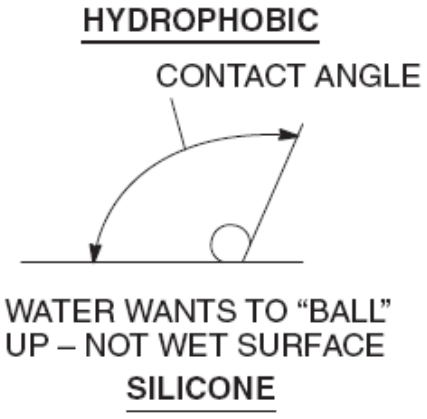
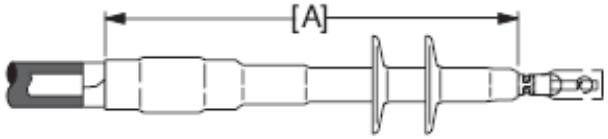


Figure 3

Physical and Electrical Properties

3M™ Cold Shrink Silicone Rubber Termination Kit QT-III, 7620-S, 7680-S and 7690-S Series can be used on cables with a rated maximum operating temperature of 105° C and an overload rating of 140° C. 7620-S, 7680-S and 7690-S Series terminations meet all requirements of IEEE Standard 48-1996, "IEEE Standard Test Procedures and Requirements for High-Voltage Alternating-Current Cable Terminations", and are designated Class 1 for outdoor weather-exposed locations. The current rating of these terminations meets or exceeds the current rating of the cables on which they are installed.

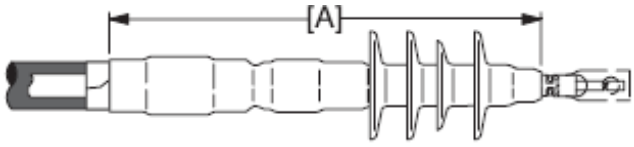
Typical Dimensions



Kit Number	Dimension [A] (Max.)	Wet Creepage Distance (Max.)	Arcing Distance Max.
7620-S-2	10.5" (267 mm)	14.0" (356 mm)	10.5" (267 mm)
7621-S-2	10.5" (267 mm)	14.0" (356 mm)	10.5" (267 mm)
7622-S-2	9.8" (249 mm)	13.3" (338 mm)	9.8" (249 mm)

Table 1

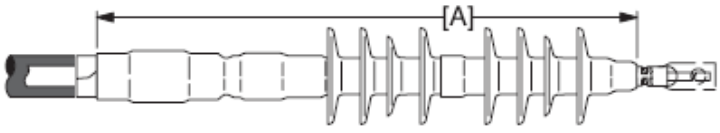
Typical Dimensions



Kit Number	Dimension [A] (Max.)	Wet Creepage Distance (Max.)	Arcing Distance Max.
7692-S-4	12.25" (311 mm)	18.5" (470 mm)	12.25" (311 mm)
7693-S-4	12.25" (311 mm)	18.5" (470 mm)	12.25" (311 mm)
7694-S-4	12.25" (311 mm)	18.5" (470 mm)	12.25" (311 mm)
7695-S-4	12.25" (311 mm)	18.5" (470 mm)	12.25" (311 mm)
7696-S-4	13.25" (337 mm)	19.5" (495 mm)	13.25" (337 mm)

Table 2

Typical Dimensions



Kit Number	Dimension [A] (Max.)	Wet Creepage Distance (Max.)	Arcing Distance Max.
7683-S-8	20.50" (521 mm)	33.00" (838 mm)	20.50" (521 mm)
7684-S-8	20.50" (521 mm)	33.00" (838 mm)	20.50" (521 mm)
7685-S-8	20.50" (521 mm)	33.00" (838 mm)	20.50" (521 mm)
7686-S-8	21.50" (546 mm)	34.00" (864 mm)	21.50" (546 mm)

Table 3

Physical and Electrical Properties

Hi-K Stress Control Tube

Physical Properties (Test Method) (ASTM D150 unless noted)	Value
Tensile Strength	1500 psi
(ASTM D412 Test Method)	
Modulus @ 100% Elongation	160 psi
Modulus @ 300% Elongation	500 psi
Electrical Properties (Test Method) (ASTM D150 unless noted)	**Value**
Dielectric Constant (K() 60 Hz; @ 1000 V; 73° F (23° C), 50% RH	22
Dissipation Factor 60 Hz; @ 1000V; 73° F (23° C), 50% RH	0.10

Hi-K Stress Controlling Compound

Electrical Properties (Test Method) (ASTM D150 unless noted)	Value
Dielectric Constant 60 Hz; @ 1000 V; 73° F (23° C), 50% RH 100 mil (2,54 mm) thickness	25
Dissipation Factor 60 Hz; @ 1000 V; 73° F (23° C), 50% RH 100 mil (2,54 mm) thickness	0.90

Silicone Sealing Compound

Electrical Properties Test Method ASTM D149	Value
Dielectric Strength 75 mil (1,90 mm) thickness	300 V/mil

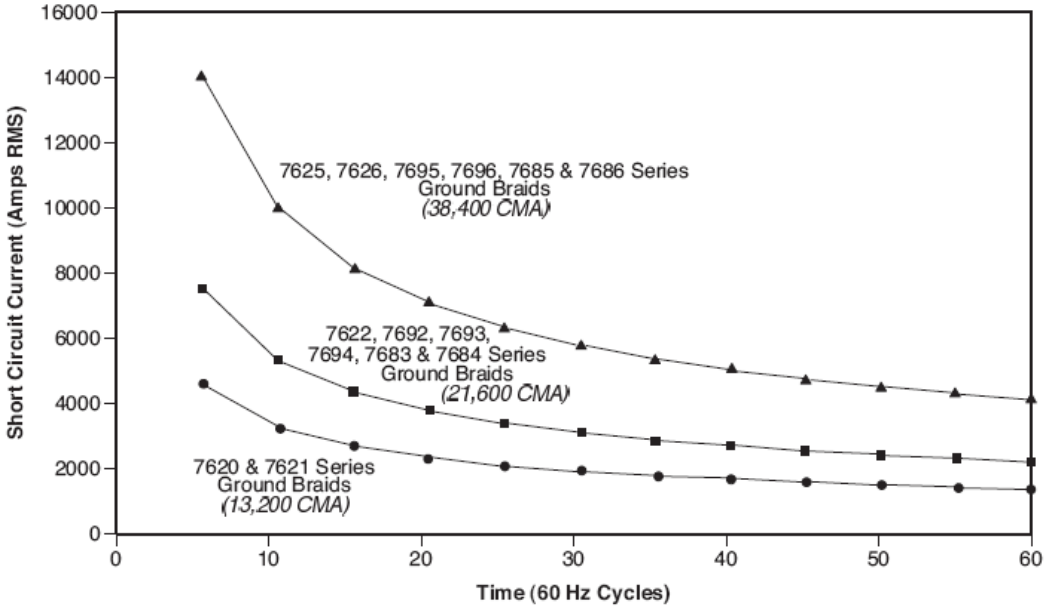
Silicone Rubber Insulator

Physical Properties (Test Method)	Value
Color	Dark Gray
Tensile Strength (ASTM D412)	850 psi
Modulus @ 100% Elongation	130 psi
Modulus @ 300% Elongation	400 psi
Hydrophobic Recovery	
(3M Test Method No. 406)	
>90° Contact Angle	5.0 hrs
Electrical Properties (Test Method) (ASTM D150 unless noted)	**Value**
Dielectric Constant (S.I.C.) 60 Hz; @ 1000 V; 73° F (23° C), 50% RH	3.6
Dissipation Factor 60 Hz; @ 1000V; 73° F (23° C), 50% RH	0.003
Dielectric Strength (ASTM D149) 75 mil (1,90 mm) thickness	500 V/mil
Track Resistance (ASTM 2303) 3.5 kV	5.0 hrs.

Physical and Electrical Properties

Ground Braid

Rated Ground Fault Current Limit



Termination Selection Guide

Kit Number	Cable Insulation O.D. Range	Conductor Size Range (AWG and kcmil)				
		5 kV 100 % 133 %	8.7 kV 100% 133%	15 kV 100% 133%	25/28 kV 100% 33%	35 kV 100% 33%
7620-S-2	0.32 – 0.59” (8,2 – 15,0 mm)	8 – 4 --	8 – 6 --	-- --	-- --	-- --
7621-S-2	0.49 – 0.89” (12,1 – 22,7 mm)	2 – 3/0 --	4 – 2/0 --	-- --	-- --	-- --
7622-S-2	0.64 – 1.08” ((16,3 – 27,4 mm)	4/0 – 400 --	3/0 – 300 --	2 – 4/0 (35 – 120 mm^2)	-- --	-- --
7692-S-4	.064 – 1.08 (16,3 – 27,4 mm	4/0 – 400 --	3/0 – 300 --	2 – 4/0 (35 – 120 mm^2)	2 – 1/0 (35 – 50 mm^2)	-- --
7693-S-4	0.72 – 1.29” (18.3 – 32,8 mm)	300 – 500 --	250 – 500 --	2/0 – 300 (70 – 150 mm^2)	2 – 4/0 (35 – 120 mm^2)	-- --
7694-S-4	0.83 – 1.53” (21,1 – 38,9 mm)	500 - 750 --	350 - 700 --	4/0 – 500 (120 – 240 mm^2)	2/0 – 250 (70 – 150 mm^2)	-- --
7695-S-4	1.05 – 1.80” (26,7 – 45,7 mm)	700 - 1500 --	600 - 1250 --	500 – 1000 (240 – 500 mm^2)	250 – 800 (125 – 400 mm^2)	-- --
7696-S-4	1.53 – 2.32” (38,9 – 58,9 mm)	1750 – 2000 --	1500 – 2000 --	1250 – 2000 (625 – 1000 mm^2)	900 – 1750 (500 – 800 m^2)	-- --
7683-S-8	0.72 – 1.29” (18.3 – 32,8 mm)	300 – 500 --	250 – 500 --	2/0 – 300 (70 – 150 mm^2)	2 – 4/0 (35 – 120 mm^2)	2 – 2/0 (35 – 70 mm^2)
7684-S-8	0.83 – 1.53” (21,1 – 38,9 mm)	500 - 750 --	350 - 700 --	4/0 – 500 (120 – 240 mm^2)	2/0 – 250 (70 – 150 mm^2)	2 – 4/0 (35 – 120 mm^2)
7685-S-8	1.05 – 1.80” (26,7 – 45,7 mm)	700 - 1500 --	600 - 1250 --	500 – 1000 (240 – 500 mm^2)	250 – 800 (125 – 400 mm^2)	3/0 – 600 (95 - 325 mm^2)
7686-S-8	1.53 – 2.32” (38,9 – 58,9 mm)	1750 – 2000 --	1500 – 2000 --	1250 – 2000 (625 – 1000 mm^2)	900 – 1750 (500 – 800 m^2)	700 – 1500 (400 – 725 mm^2)

Product Specifications

The cable termination must have a voltage class rating equal to or greater than the cable being terminated. The rating shall be 5, 8.7, 15, 25/28 kV or 34.5 kV as an IEEE Standard 48-1996 Class 1 termination. It must have a maximum continuous operating temperature rating of 105° C, with an emergency overload rating of 140° C. The termination stress control shall be capacitive and constructed of a Hi-K EPDM rubber tube. The installation procedure shall not require using silicone grease. The termination insulator shall be of a skirted design, constructed of tracking resistant silicone rubber, dark gray in color. The termination must be of a pre-stretched Cold Shrink design, installed without the application of a heat source. The termination kit shall include all materials required (except lug and vinyl tape) and shall accommodate tape (ribbon), wire, or UniShield® shielded cables.

The Class 1 termination kits shall be used with listed copper or aluminum compression lugs.

Engineering/ Architectural Specifications

Terminating of all 5, 8.7, 15, 25/28 and 34.5kV shielded power cables, indoors and in weather-protected equipment shall be performed in accordance with instructions included in the 3M™ Cold Shrink Silicone Rubber Termination Kit QT-III 7620-S,7680-S and 7690-S Series. This shall include all outdoor weather-exposed areas for tape (ribbon), wire or UniShield® shielded cables. The termination kits shall be used in conjunction with 3M™ Scotchlok™ Connector 3000 or 4000 Series or 3M™ Stem Connectors SC Series.

Performance Tests

Typical Results, IEEE Standard 48 Short-Term Test Sequence

Insulation Class Test	5 / 8.7 kV (2 Skirt)		15/25 kV (4 Skirt)		34.5 kV (8 Skirt)	
	Require-ments	Results	Require-ments	Results	Require-ments	Results
Partial Discharge Extinction voltage @ 3 pC	7.5 kV	Passed	13 / 21,5 kV	Passed	30 kV	Passed
Power Frequency Voltage 1 min. Dry Withstand	35 kV	Passed	50 / 65 kV	Passed	90 kV	Passed
Power Frequency Voltage 10 sec, Wet Withstand	30 kV	Passed	45 / 60 kV	Passed	80 kV	Passed
Power Frequency Voltage 6 hr. Dry Withstand	25 kV	Passed	35 / 55 kV	Passed	76 kV	Passed
Direct Voltage 15 min. Dry Withstand	65 kV	Passed	75 / 105 kV	Passed	140 kV	Passed
Lightning Impulse Voltage Withstand (BIL)	95 kV	Passed	110 / 150 kV	Passed	200 kV	Passed
Partial Discharge Extinction Voltage @ 3 pC	7.5 kV	Passed	13 / 21.5 kV	Passed	30 kV	Passed

Table 4

Performance Tests

Typical Results, IEEE Standard 48 Long-Term Test Sequence

Insulation Class Test	5 / 8.7 kV (2 Skirt)		15/25 kV (4 Skirt)		34.5 kV (8 Skirt)	
	Require-ments	Results	Require-ments	Results	Require-ments	Results
Partial Discharge Extinction voltage @ 3 pC	7.5 kV	Passed	13 / 21.5 kV	Passed	30 kV	Passed
Cycling Aging 30 days, 130° C cond. temp Power Frequency voltage Withstand	35 kV	Passed	26 / 43 kV	Passed	60 kV	Passed
Partial Discharge Extinction Voltage @ 3 pC	7.5 kV	Passed	13 / 21.5 kV	Passed	30 kV	Passed
Lightning Impulse Voltage Withstand (BIL)	95 kV	Passed	110 / 150 kV	Passed	200 kV	Passed

Table 5

Partial Discharge (Corona) Tests

The purpose of corona testing is to determine whether all properly installed terminations operate corona-free at a minimum of 150% of their operating voltage. For the test, an applied test voltage is gradually increased until discharges appear on the test set oscilloscope display. The voltage at which these discharges reach a magnitude of 3 picocoulombs is recorded as the corona starting voltage (CSV). The applied voltage is then lowered until the discharge level drops below 3 picocoulombs, and this is recorded as the corona extinction voltage (CEV).

Power Frequency (AC) Withstand Tests

All 3M™ Cold Shrink Silicone Rubber Termination Kit QT-III, 7620-S,7680-S and 7690-S Series exceed the IEEE Standard 48-1996 requirements for a Class 1 termination.

Lightning Impulse Tests

For these tests, a 1.2 x 50 microsecond voltage wave is applied to the termination lug. The testing consists of both positive and negative polarity surges per IEEE Standard 48-1996 BIL requirements. The termination kits exceed these BIL requirements.

Sealing Tests

Termination top and bottom seals are tested by applying 7 psi (0.05 MPa) to the cable conductor strands with the termination submerged in water. Both seals withstand this internal air pressure for 6 hours without leaking.

Installation Techniques

Detailed instructions are included in each kit to provide the installer with all information required to properly install the appropriately sized 3M™ Cold Shrink Silicone Rubber Termination Kit QT-III, 7620-S,7690-S and 7680-S Series. A brief summary of the installation steps for tape-shielded cable is outlined as follows:

1. Prepare cable according to standard procedure.

2. Apply bottom mastic seal. (*Figure 4*).

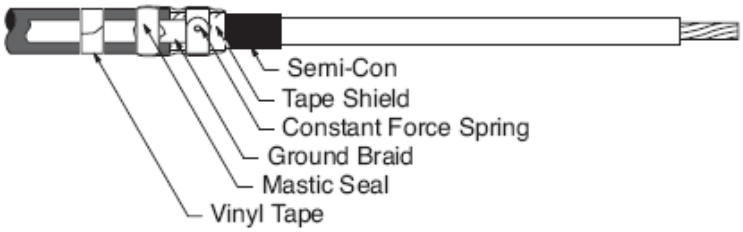
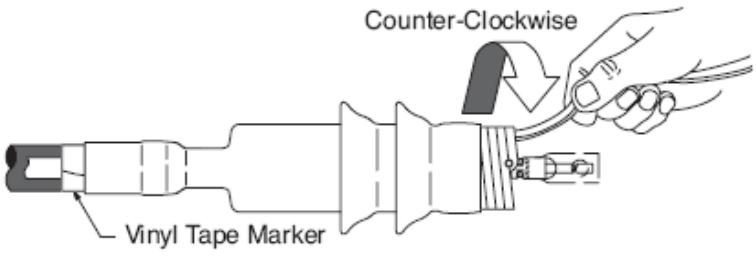


Figure 4

3. Install lug using a listed crimping tool and die.

4. Install termination onto cable and unwind core, allowing termination to shrink into place (*Figure 5*).

> **⚠ Caution**
>
> Working around energized high-voltage systems may cause serious injury or death. Installation should be performed by personnel familiar with good safety practice in handling high-voltage electrical equipment. De-energize and ground all electrical systems before installing product.



NOTE: The material being removed at this step is mixed polymers and can be recycled with other waste.

Figure 5

Shelf Life & Storage

Maximum recommended storage temperature is 110° F (43° C). The termination assemblies are not affected by freezing storage temperatures. Normal stock rotation is recommended. As provided, in the expanded state, 3M™ Cold Shrink Silicone Rubber Termination Kit QT-II 7620-S, 7690-S and 7680-S Series terminations have an on-shelf storage life of three years from the date of manufacture.

Maintenance

Surface Cleaning – 3M QT-III terminations are not harmed by field surface cleaning. Established techniques for cleaning insulators and terminations in extremely contaminated areas such as high-pressure water and pulverized corn cobs are acceptable.

Availability

Please contact your local distributor; available from 3M.com/electrical [Where to Buy] or call 1-800-245-3573.

Important Notice:

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